THE HARVEIAN ORATION

1865.

HENRY W. ACLAND

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THE HARVEIAN ORATION

1865.

BY

HENRY W. ACLAND,

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AND

HON. PHYSICIAN TO H. R. H. THE PRINCE OF WALES.

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TO

THOMAS WATSON, M.D., F.R.S., D.C.L.,

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS

OF ENGLAND,

THE FOLLOWING ORATION,

DELIVERED AND PRINTED BY HIS DESIRE,

IS NOW GRATEFULLY

DEDICATED.

OXFORD, 1865.

THE HARVEIAN ORATION,

1865.

WE celebrate once more the memory of those who in past times have brought honour to the College of Physicians of England; the memory also of those who have recently gone, of Kirkes, whose learning and skill were appreciated, and whose loss is lamented, wherever medical literature is known, of Turner, of the worthy brother of noble-hearted Southey, of Bird, and Duke, of one not yet laid in his grave, whose strong nature brought great fruit to others, to us, to himself—Ferguson; but above all of HARVEY, Founder of this commemorative Holyday. Happy we whom custom and his direction withdraw for a brief hour from the din and care of life to this peaceful task!

The occasion is singular. It might have been better if, when for the first time in History, HARVEY is discussed in his native tongue before the College he loved so well, the Cicero of English Medicine, as our

President has been justly called, had inaugurated this new series of discourses.

With combined authority and skill, Dr. Watson might have sketched with his strong yet pleasant touch the personal character of our Master; and would have drawn the old familiar man, keen of eye, small of stature, and gentle of mien. He might have set him before us a young and eager student with hair as black as raven, intent on his knife, or expounding its teachings; he might have shewn him later a peaceful contemplative man, now with head like snow, seated under a hedge with the Prince of Wales and his brother the Duke of York by his side[a], reading with them, till dislodged by a cannon ball, near the inn called Sun Rising, (even now standing on the glorious slope of Edge Hill,) whence he could see the battle raging at his feet below. Or, pursuing another course, our President might have shewn in long array what consequences have followed, and what may yet follow, from the accurate study of the laws which regulate the circulation of the blood in the animal kingdom; and have

[a] Letters of John Aubrey, vol. ii. part ii. p. 379.

given us his matured views of the relations of the vital fluid to the organism in health, and to the organism in disease; expounding principles for the philosophy, and deducing rules for the practice, of Medicine; telling us of disease averted, of health maintained, or of health restored.

Called upon this day to perform, with unequal power, the task which I wish had fallen into worthier hands, I propose to treat of one general topic; viz. how far some points in Harvey's Methods of Discovery are in accordance with the ideas which the experience of advancing Science has taught. If it can be shewn that, after the lapse of two centuries, not only his discoveries were valuable but his methods were correct, we may with renewed confidence begin a fresh series of annual Scientific Essays, which the College has wisely decided to ask from its working and zealous Fellows.

HARVEY is popularly known by only one of his works, that no doubt which has been most fruitful, but not that probably which caused him most labour. The studies which

led to the discovery of the Circulation of the Blood could not have cost him more research than he expended on investigating, with the princely aid of his Royal Master's park at Windsor, the Generation of Animals.

But also he is familiarly known, because historians quote him as a notable instance of a Philosopher, who studied Nature under the conviction that every arrangement in the Natural World is the result of *Design*— that every effect is *intended and has a Purpose.* It is this persuasion, says Whewell[b], "which directed the researches, and led to the discoveries of Harvey."

Harvey is on this account more often referred to by Theologians than any other Biological discoverer. Success does not always explain or justify the means, and therefore it is, at the present day, a matter of extreme interest to know whether he did so make his discovery: and, if he was in a great measure guided in his researches by the idea of Final Causes, whether he followed a safe and proper scientific method.

The last of these questions must be con-

[b] Whewell's Indications of a Creator, p. 119.

sidered before the first; and among men of mark whose opinions are entitled to weight, this question would now be answered in opposite ways, as the two following quotations will incontestably shew.

1. The great English Historian of Science, besides elaborate disquisitions in favour of the study of Final Causes, gives his deliberate opinion in his most matured work[c], that "the idea of a Final Cause is an indispensable guide in Biology."

2. On the other side, his French rival, whose genius, industry, and learning cannot be spoken of but with respect, and who is held up by some as the most advanced Philosopher of our time, says[d], with regard to one department of modern science[e], "that it represents the order of the world as the necessary and spontaneous result of the mutual action of the principal masses of which it is composed, at the same time that it ruins with irresistible evidence the hypothesis of Final Causes, and of all Providential Government."

[c] Whewell, Novum Organon renovatum, 1858, p. 138.

[d] Comte, Cours de philosophie positive. Ed. Littré, 1864, vol. iii. p. 321.

[e] Astronomy.

By selecting the opinions of two recent authors of undisputed learning and power, we are able to dismiss from consideration a mass of writers of older date or of inferior calibre, and at once to mark the issue of a question which is now agitating deeply, though often silently, the minds of men who think, either in Science or in Theology.

The idea of Final Cause is essential as a guide in the progress of Biology, says Whewell.

The idea of Final Cause and Providential Government is ruined by the irresistible evidence of Modern Science, says Comte.

There is one fundamental error, as seems to me, (and it may as well be pointed out at once,) in Comte's statement of the case. The doctrine of Final Causes, so far as it involves the idea that we *are able to state the object* for which things exist, may be ruined; but it does not follow that the belief in a Providential Government of the universe may not remain. The two things are quite different, and they are not necessarily related. We may be satisfied on the whole that there is, behind all the efficient causes which we can

see, a First Cause, which we believe (on whatever ground) to be a Supreme Will and Intelligence, and yet we may be quite unable to trace the intermediate steps by which that Will operates, or even to prove its operation. And if we cannot trace the intermediate steps, or their mutual connexion, we cannot safely apply the idea of Final Cause as a certain means of scientific investigation, especially as there may be several Final Causes for the same condition. We may therefore discard the *use* of Final Causes in Science and yet not necessarily infer, as Comte did, the absence of Providential Government. This was the conclusion, for instance, of one of Harvey's greatest admirers, the famous René Descartes.

Descartes says[f],—

"Nullas unquam rationes circa res naturales, a fine, quem Deus aut natura in iis faciendis sibi proposuit, desumemus; quia non tantum debemus nobis arrogare, ut ejus consiliorum participes nos esse putemus."

And again, in the Meditations,—

"Non enim absque temeritate me puto posse investigare fines Dei[g]."

[f] Principia Philosophiæ, I. § 28.

[g] Medit. IV.

In a different way, but somewhat to the same effect, Kant, while fully admitting the beauty and order of the Universe, refuses to acknowledge this beauty and order as amounting to scientific proof of the existence of a Supreme Will.

"The right contemplation," he says, "of a well-meaning mind on so much casual beauty, and so much combination answering the end, as the order of nature displays, finds proofs enough to gather from them a Will accompanied with great wisdom and great power; and the common conceptions of the understanding are sufficient to this conviction, so far as it shall suffice for a virtuous conduct, that is, be morally certain. . . . . .

"The principal characteristic of the physicotheological method hitherto used is this, that the perfection and the regularity are first properly comprehended as to their casualty, then the artificial order is shewn according to all its references answerable to the end in order thence to conclude a wise and a good will, and the conception of the immense power of the Author is, by the superadded consideration of the magnitude of the work, afterward united with it.

"This method is excellent: in the first place, because the conviction is sensual, and consequently lively and engaging, easy and comprehensible to the most common intellect; because it, in the second place, is more natural than any other, as there is no doubt but everybody makes the beginning with it; and because it, in the third place, affords a conception, accompanied with much intuition, of great wisdom, care, or even potency of the adorable Being which fills the soul, and has the greatest power of raising astonishment, humility, and awe. This mode of proof is more practical than any other, even with regard to the philosopher. For though he does not find in it the determinate abstract idea of the Godhead for his searching understanding, and the certainty itself is not mathematical, but moral, so many proofs, every one of them of so great energy, take possession of his soul, and speculation follows quietly with a certain confidence and conviction which had previously taken place. One would hardly risk his whole happiness on the pretended rightness of a metaphysical proof, particularly if lively sensual persuasions stood in its way. But the force of conviction which springs from this argument is, just by reason of its being so sensual, so

great, that the physicotheologist is apprehensive of no danger from syllogisms and distinctions, and far above minding the power of subtile objections[h]."

Lastly, on this point I may cite the opinion of a great anatomist of our own. Professor Owen rejects the idea of Final Cause in the ordinary acceptation of Purpose or Design with a view to Use, and yet strongly maintains the doctrine of a Supreme Intelligence. He supports the hypothesis that complex arrangements in the organic world are expanded from a simple form, according to a pre-ordained plan.

"The attempt to explain" (he says in his work on the Homologies of the Vertebrate Skeleton) "by the Cuvierian principles the facts of special homology on the hypothesis of the subserviency of the parts so determined to similar ends in different animals—to say that the same or answerable bones occur in them because they have to perform similar functions—involve many difficulties, and are opposed by numerous phænomena[i]."

[h] Kant's Physiotheology, translated by Richardson, p. 134. See also Appendix, Note A.

[i] Owen's Homologies of the Vertebrate Skeleton, p. 73.

After giving illustrations from the development of the skull of Vertebrates, he proceeds:—

"These and a hundred such facts force upon the contemplative anatomist the inadequacy of the teleological hypothesis to account for the acknowledged concordances expressed in this work by the term 'special homology.' If, therefore, the attempt to explain them as the results of the similarity of the functions to be performed by such homologous parts, entirely fails to satisfy the conditions of the problem; and if, nevertheless, we are, with Cuvier, to reject the idea of their being manifestations of some higher type of organic conformity, on which it has pleased the divine Architect to build up certain of his diversified living works, there then remains only the alternative that special homologies are matters of chance.

"This conclusion, I apprehend, will be entertained by no reasonable mind; and reverting, therefore, to the more probable hypothesis of the dependence of the special resemblances upon a more general law of conformity, we have next to inquire, What is the vertebrate archetype?"

Here it is to be observed that the idea of contrivance for the sake of utility (ordinarily so called) is pronounced inadequate. The far more subtle suggestion is supported, that of a Creator working on a plan within self-imposed limits. Owen's archetype is not, however, an archetype in Plato's sense. Plato's ideal was the absolute form of every species, which existed only as a divine perfection, and expressed itself more or less imperfectly in each individual of the species. Owen's archetype is the abstraction which can be made from all complex organisms of the same kind. But though the Professor in this work, (of which it may be said that it spread in this country a profound interest in the minutest details of osseous structure in vertebrate animals, and therefore constitutes a veritable epoch in the annals of British Philosophic Anatomy,) relinquishes the common hypothesis of Final Causes, he yet advocates, though in a particular form no doubt, the idea of comprehensive plan or unity of design as well as mechanical skill in the works of nature. And this idea is one with which, in

some form or other, the philosophic observer of Nature cannot safely dispense, without sacrificing all hope of attaining any conception at all of nature as a whole. For it is involved in the notion of Art, as a thing distinct from mere mechanical adaptation; and it is only from considering the operation of the Artist's mind that our limited faculties can derive any conception of the work of Creation. Indeed, Art in its highest sense is Creation. It may, and often does, consist of an unexpressed subjective image—mechanical, or pictorial, or poetical. Tennyson's burning thoughts not yet rendered into musical verse, Raffaele's sense of beauty not yet embodied in a picture, Babbage's wheel and cog still existing only in his own ingenious mind, have each a subtle Being, though not objectively expressed. Each gives a faint reflexion of what we dimly, and perhaps incorrectly, conceive, by analogy, of the Ideas existing in the Supreme Mind with respect to Its works and operations.

The illustration of the watch, so quaintly employed by Nieuwentyt[j], and so entirely

[j] See Appendix, Note B.

appropriated by Paley, only in a coarse way suggests the parallel between Infinite Art and common Mechanical Skill. It has done some mischief to the cause it advocates, by making familiar a rude illustration, which minds without imagination, or devoid of constructive power, have accepted as a recognized explanation of the method of operation by an Infinite Creative Will.

Such persons, then, as Descartes, Kant, and Owen, while disavowing on various grounds the adequacy of the argument from Final Causes, or from intended and recognizable purpose, admit, indeed require, the presence of a superior operating Will, *of which we recognize the results while we cannot divine the motive.*

Even Mr. Herbert Spencer, who in one place argues elaborately against all notion of Design, in another expresses the necessity of acknowledging a Creator, or at least a First Cause. On the one hand, in one of the chapters in the "Principles of Biology," he takes the instance of human Entozoa to prove that either the system of things is not

specially ordered by a Supreme Will, or that if ordered it is ordered amiss[k]. On the other hand, he writes thus:—

"Either the multitudinous kinds of organisms that now exist, and the still more multitudinous kinds that have existed during past geologic eras, have been from time to time separately made, or they have arisen by insensible steps, through actions such as we see habitually going on. *Both hypotheses imply a Cause. The last, certainly as much as the first, recognizes this Cause as inscrutable. The point at issue is, how this inscrutable Cause has worked in the production*

[k] Great stress is laid by Mr. Spencer on the presence of Entozoa in Man. He implies that if Design is predicated of the natural world, then there is the dilemma of want of skill, or want of power to hinder evil, on the part of the Designer. This is one instance, no doubt, of the existence of evil in the world which we cannot explain. We know of no adequate end to be obtained through the agency of tapeworm, or other parasites. Man is not exempt from these evils. Nor is he exempt from other diseases. Tubercle, inflammation, cancer, are in some respects as inexplicable as are parasites. Care and the observance of the laws of health lessen these visitations, and these strange and loathsome parasites among the rest. But the subject is far too complex to be treated in a note.

of living forms. This point, if it is to be decided at all, is to be decided only by examination of evidence[1]."

These writers, then, all acknowledge something like a Creating Cause, and none of them (save the last) disavow Design, though they doubt their own powers of reading it. Their authority may dispense us from the necessity of further considering M. Comte's denial of Providential Government. But in respect to the argument from Design, these authors to a certain extent agree with him. M. Comte, however, goes further than any other opponent of Final Causes whom I I have yet met with. He declares all argument from Design in the Universe to be worthless as argument, and he takes a crucial instance to prove that the Design, if it exist, is bad.

Now Comte's crucial instance is as follows. He is speaking of the education proper for fitting men rightly to pursue scientific studies. He says that in Biology the scientific spirit leads us to the conviction that *there can be no organ without function, nor*

[1] Principles of Biology, vol. i. p. 332.

functions without organ. This conviction, he says, is eminently philosophic; but he proceeds:—

"Il faut convenir que cette tendance systématique à regarder tout organe quelconque comme exerçant nécessairement une certaine action, dégénère encore très-fréquemment en une aveugle admiration antiscientifique du mode effectif d'accomplissement des divers phénomènes vitaux. Une semblable disposition, émanation évidente de l'ancienne suprématie théologique, est en opposition directe avec toute saine interprétation du principe des conditions d'existence, d'après lequel, quand nous avons observé une fonction quelconque, nous ne saurions être surpris que l'analyse anatomique vienne réellement dévoiler, dans l'organisme, un mode statique propre à permettre l'accomplissement de cette fonction[m]."

["It must be admitted that such a systematic tendency to consider any organ whatever as exercising necessarily a certain action, very frequently degenerates also into a blind antiscientific admiration for the actual method of accomplishment of the divers vital

[m] Cours de Philosophie Positive, vol. iii. p. 321.

phenomena. Such a disposition—an evident emanation of the old theological supremacy—is in direct opposition to sound interpretation of the principle of the conditions of existence, according to which, after observing any function whatsoever, we cannot be surprised that anatomical analysis should indeed discover in the organism means calculated to allow that function to be performed."]

On this passage it need only be remarked negatively, that admiration may exist without blindness; and positively, that it may coexist with the most critical investigation and the most accurate estimate of the object of it. But it is important to Comte's argument to make love of Nature—one of the simple, joyous, and pure pleasures of the noblest minds—appear antiscientific and mischievous. Having, therefore, coupled the quality of blindness with that of admiration, he proceeds,—

"Cette admiration irrationelle et stérile, en nous persuadant que tous les actes organiques s'opèrent aussi parfaitement que nous puissions l'imaginer, tend immédiate-

ment à comprimer l'essor général de nos spéculations biologiques: elle conduit souvent à s'émerveiller sur des complications évidemment nuisibles."

["This irrational and barren admiration, by persuading us that all organic actions are effected as perfectly as we can imagine, tends immediately to press down by force the spring from which all our biological speculations receive their impulse: it leads us frequently to marvel over complications evidently detrimental."]

Admiration of Nature then is blind; it is also irrational, and barren: for it would persuade us that every organic act is executed as perfectly as is possible, and thus restrain the flight of our speculations on subjects which we admire and love. "Admiration indeed often delights itself with complexities which are hurtful."

Having thus sketched the frame of mind of lovers of Nature, he produces the crucial example of which I spoke to prove the absurdity of their condition.

"On peut, à ce sujet, indiquer, comme un

exemple frappant de cette absurde disposition, la puérile affectation de certains philosophes à vanter la pretendue sagesse de la nature dans la structure de l'œil, particulièrement en ce qui concerne le rôle du cristallin, dont ils sont allés jusqu'à admirer l'inutilité fondamentale, comme s'il pouvait y avoir beaucoup de sagesse à introduire aussi intempestivement une pièce, viz. qui n'est point indispensable au phénomène, et qui néanmoins devient, en certains cas, capable de l'empêcher entièrement."

["One may mention, on this subject, as a striking instance of this absurd tendency, the puerile affectation of certain philosophers in commending the pretended wisdom of nature as shewn in the structure of the eye, particularly in reference to the action of the crystalline lens, the fundamental uselessness of which they have gone so far as to admire: just as if there could be much wisdom in the inopportune introduction of a part which is not indispensable to the phenomenon, and which may nevertheless in certain cases prevent it entirely."]

Some apology may seem needed for occupying the College in the discussion of this

passage; but the time is gone by, if it ever existed, when it is justifiable to meet the deliberate criticisms of able men by neglect. For my own part, recognizing the skill, industry, and genius of M. Comte, and the esteem in which parts of his literary labours are very properly held, I am grateful that he should have thrown down the gauntlet in a manner so unmistakeable, for the acceptance of those who believe themselves to be able to criticise, to love, and to revere the manifestation of Order, and of what they take to be Design in the Universe.

But it must here be said, that these opinions are not new. Hear Lucretius on the same point:—

"Illud in his rebus vitium vementer avessis
Effugere, errorem vitareque præmetuenter,
Lumina ne facias oculorum clara creata,
Prospicere ut possemus; et ut proferre queamus
Proceros passus, ideo fastigia posse
Surarum ac feminum pedibus fundata plicari;
Bracchia tum porro validis ex apta lacertis
Esse manusque datas utraque ex parte ministras,

Ut facere ad vitam possemus quæ foret usus.
Cetera de genere hoc inter quæcumque pretantur,
Omnia perversa præpostera sunt ratione,
Nil ideo quoniam natumst in corpore ut uti
Possemus, sed quod natumst id procreat usum.
Nec fuit ante videre oculorum lumina nata
Nec dictis orare prius quam lingua creatast,
Sed potius longe linguæ præcessit origo
Sermonem multoque creatæ sunt prius aures
Quam sonus est auditus, et omnia denique membra
Ante fuere, ut opinor, eorum quam foret usus;
Haud igitur potuere utendi crescere causa.
At contra conferre manu certamina pugnæ
Et lacerare artus fœdareque membra cruore
Ante fuit multo quam lucida tela volarent,
Et volnus vitare prius natura coegit
Quam daret objectum parmai læva per artem.
Scilicet et fessum corpus mandare quieti
Multo antiquius est quam lecti mollia strata,
Et sedare sitim prius est quam pocula natum.
Hæc igitur possent utendi cognita causa
Credier, ex usu quæ sunt vitaque reperta.
Illa quidem seorsum sunt omnia quæ prius ipsa

Nata dedere suæ post notitiam utilitatis.
Quo genere in primis sensus et membra videmus;
Quare etiam atque etiam procul est ut credere possis
Utilitatis ob officium potuisse creari[n]."

[n] "And herein you should desire with all your might to shun the weakness, and with a lively apprehension to avoid the mistake of supposing that the bright lights of the eyes were made in order that we might see; and that the tapering ends of the shanks and hams are attached to the feet as a base, in order to enable us to step out with long strides; or again, that the fore-arms were slung to the stout upper-arms, and ministering hands given us on each side, that we might be able to discharge the needful duties of life. Other explanations of like sort which men give, one and all put effect for cause through wrongheaded reasoning; since nothing was born in the body that we might use it, but that which is born begets for itself a use: thus seeing did not exist before the eyes were born, nor the employment of speech ere the tongue was made; but rather the birth of the tongue was long anterior to language, and the ears were made long before sound was heard; and all the limbs, I trow, existed before there was any employment for them: they could not therefore have grown for the purpose of being used. But on the other hand, engaging in the strife of battle, and mangling the body and staining the limbs with gore, were in vogue long before glittering darts ever flew; and nature prompted to shun a wound, or ever the left arm by the help of art held up before the person the defence of a shield. Yes, and

Nothing can be more clearly or tersely put. There is no intention in the Eye, no Design. Use is the consequence of existence. Existence came by chance. All the fine mechanical contrivance by which light, the subtlest of known matter, becomes a source of knowledge to the higher animals, happened to exist; light happened to enter, and we see—and seeing, know. Oh! creed hard to believe! Design is barred to me. Chance is left. And this fruit of chance is beneficially, but without intention, transmitted with precision from generation to generation.

We have indeed lately seen a remarkable

consigning the tired body to rest, is much older than a soft-cushioned bed, and the slaking of thirst had birth before cups. These things therefore which have been invented in accordance with the uses and wants of life, may well be believed to have been discovered for the purpose of being used. Far otherwise is it with all those things which first were born, then afterwards made known the purposes to which they might be put; at the head of which class we see the senses and the limbs. Wherefore again and again I repeat, it is quite impossible to believe that they could have been made for the duties which they discharge." —*Lucretius*, b. iv. l. 823–857. Ed. Munro, 1864, vol. i. p. 189.

attempt to reduce the doctrine of what used to be called Chance to an orderly philosophic system. Mr. Darwin accounts for the structure of the Eye not by Chance but by Natural Selection.

"To suppose," he says, "that the eye, with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree. Yet reason tells me, that if numerous gradations from a perfect and complex eye to one very imperfect and simple, each grade being useful to its possessor, can be shewn to exist; if, further, the eye does vary ever so slightly, and the variations be inherited, which is certainly the case; and if any variation or modification in the organ be ever useful to an animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, can hardly be considered real[o]."

[o] Darwin, Origin of Species, p. 186.

This passage makes it plain that M. Comte cannot count Mr. Darwin among his followers, since the latter philosopher in no way derogates from the splendour of the instrument, but only attempts to account for the mode of its construction. M. Comte, on the other hand, seems not only to follow Lucretius in attributing the Eye to Chance, but holds, as one might expect, that the result is bad,—bad in two ways :—

1st. In that the crystalline lens is not indispensable for the purpose of vision.

2nd. In that, though not necessary for vision, it becomes in certain cases capable of impeding it altogether.

Nor is this all. For a conclusion follows which must not be unnoticed—that the course of nature as it is, is inferior to what it might have been if under the control of human intelligence.

"Quoique notre imagination reste nécessairement circonscrite, en tous genres, dans la seule sphère de nos observations effectives, et que, par suite, il nous soit surtout impossible d'imaginer des organismes radicalement nouveaux, on ne saurait douter,

néanmoins, ce me semble, que le génie scientifique ne soit aujourd'hui, même en biologie, assez développé et assez émancipé pour que nous puissions directement concevoir, d'après l'ensemble de nos lois biologiques, des organisations qui diffèrent notablement de toutes celles que nous connaissons, et qui leur seraient incontestablement supérieures sous tel point de vue déterminé[p], sans que ces améliorations fussent inévitablement compensées, à d'autres égards, par des imperfections équivalentes[q].

[" Although our imagination remains necessarily circumscribed in all respects within the sphere of actual observation, and, in consequence, it is impossible for us to imagine organisms radically new, we cannot doubt, as appears to me, that the genius of science is now sufficiently developed and sufficiently free for us to be able directly to conceive, in conformity with the aggregate of our biological laws, organisms which differ notably from all that we know, and which would be incontestably superior to them under a definite point of view, while

[p] Compare the more modest opinion of the great practical Naturalist just quoted, below at p. 40.

[q] Comte, Cours de Philosophie Positive, vol. iii. p. 322.

these ameliorations might not be inevitably balanced, in other respects, by equivalent imperfections."]

In weighing arguments of this kind, we must not be slow to admit, first, that our faculties are so far limited that we are not able to discover with certainty all the conditions necessary for producing a structure so complicated as the Eye; and secondly, that such structure, when made, is still within the range of action of the more general laws which regulate matter on the earth.

For, of the cause of the origin of any given structure, as the Eye, no more is known than of that of any other organic structure. The whole process is not within the range of the human mind to comprehend. We can only predicate of it, with Comte, the phænomena which we are able to investigate.

An Eye, considered philosophically, is the connecting machinery between light and a recipient consciousness.

As an instrument, it fails in its purpose[r],

[r] No excuse is made for the assumption, in this part of the argument, of purpose and adaptation. To avoid it

if it be not adapted to the laws of light on the one hand, and to the psychological capacities of the animal on the other.

When objection is taken to it, it has to be shewn,

either, that it does not transmit light in a suitable manner;—

or, that while it transmits light correctly, the mode of transmitting the impression to the consciousness is faulty;—

or, that being constructed reasonably in these particulars, it is liable to derangement beyond that which belongs proportionably to it as a delicate organic structure in a world where existence implies change;—

or, that being delicate, and reasonably maintained in existence, it is liable to an extraordinary amount of risk from accidents which might have been guarded against.

Now, it may be answered categorically to each and all of these,

would require an amount of periphrasis which were intolerable. Moreover, it is necessary in a brief summary to speak of the Eye as a whole,—as though there were one kind of eye, whereas there are many kinds, acting in different ways, and imparting knowledge different in amount and in quality.

that the eye does transmit light with marvellous precision, so as to produce of necessity a certain result; constructed as it is it can produce no other, unless disarranged in some part;—

that as a fact it does through impression on the retina convey knowledge adapted to the capacities of animals generally, and man in particular, of the most amazing kind;—

that it is, all things considered, liable to exceptionally few derangements: those incident, as one may say, to a structure which is part of the whole organic system of things in this planet;—

that, being in the nature of the case delicate in an extreme degree, there are an unusual number of complex arrangements which do preserve it, whether they were designed to preserve it or no.

These assertions require no proof for the expert, and to prove them as for the animal kingdom in general, to the uninstructed would require a very elaborate treatise[s], as

[s] There is a most elaborate literature on the Eye, for which see Helmholtz, Physiologische Optik, in "Karsten's Encyclopædie," and Kölliker, "Microscopic Anatomy,"

any one may see for himself by referring to the work of Donders "On the Accommodation of the Eye alone." The present discussion must be therefore strictly confined to what is requisite for appreciating the value of the lens, the special object of M. Comte's animadversions.

The crystalline lens, he says, is unnecessary, and by its diseases destroys the eye.

First of all, it is unnecessary.

This allegation is true. Though we could not see quite as well without it, still we could see. The crystalline lens is not an essential part of an eye, abstractedly considered. It does not therefore exist in every case where there is an Eye. Accordingly a person who believes that the order of things is on the whole governed by a purpose, inclines to the supposition, that when it is absent, it is unnecessary, and that, when it

p. 583. Notwithstanding this, I cannot but think that it would be a fit work for some wealthy person or society to prepare an elaborately illustrated Monograph on this organ of organs, treated psychologically and anatomically through the animal series, adding from time to time such knowledge as is obtained of its refinements, even now not completely understood.

is present, it is requisite, or at least very useful. To discuss on this occasion all the cases where it is present, and all where it is absent, is impossible. But, in order to understand the value of any one lens in an instrument, we must take into account the character of that instrument as a whole. And, bearing this in mind, it is not difficult to demonstrate the relation between the presence or absence of this lens and the circumstances of the creature in which it is present or absent.

It may be laid down as an axiom that there is no structure, which throughout the whole animal kingdom is more conformable to the general conditions of the individual, than the eye, and that without any regard to the place of that individual in the supposed scale of beings. It has, that is, exact relation to the physical habits and mental capacity of the animal, within the mechanical limits of the plan or type of the division in which the animal exists; of which only these two illustrations can here be given.

1. In animals of low nervous organization, and, as we infer, possessing little or no con-

sciousness, and few, if any, mental qualities, the lens proper is absent, and a cup-shaped spot of pigment terminates a nerve which becomes then the recipient of impressions from calorific rays. The direction of the light is made known as we suppose, and some pleasure perhaps imparted; but no accurate optical image can be formed, as far at least as we may argue from the laws of the formation of images on the retina of more complete eyes. The lens here can do, and does, neither harm nor good; for it is absent. This seems to be the case among Acalephæ, for instance, and in Pecten. The general character of such animals justify the deficiency.

2. In the higher animals generally, and in some of the lower, the eye is constructed on the type in which a lens is present.

This type, briefly stated, consists of a transparent refracting cornea, having a curve or facets varying according to the conditions of life; of a refracting medium anterior to a lens, which varies from a low degree of convexity, equal or different on either surface, to that of a sphere, this lens

being imbedded on the face of a fourth refracting medium (the vitreous humour). This optical apparatus has a moveable diaphragm in the more perfect eyes (by which spherical aberration is corrected). It brings rays of light to a focus on the termination of the optic nerve.

The nerve structures (*bacilli, cones*) on which these impressions are made, are, according to Kölliker, in man not more than 0,008‴ broad. Now it is true, as Comte alleges, that the lens is not necessary for the transmission of light nor for the bringing it to a focus, if the focus be at a fixed point; or in other words, for objects at one distance. It is also true that an eye may be constructed with a simple refracting medium without a lens for viewing objects at one distance. Such seems to be the case with many insects; and truly their immoveable eyes constructed on this plan, with many thousand corneal facets, each having an elongated refracting medium, surrounded by delicate non-reflecting pigment, and corresponding nerve-fibrils of great tenuity, are very masterpieces of fine mechanism

among the finer mechanisms of life. Though they have no moveable lens, it cannot be said they do not ensure acute powers of vision. The rapid motions of the common dragon-fly, for instance, must satisfy any one as to the fact. But these eyes are not always the sole-imparters of the lessons from light. For in many insects, as for example the bee, there are additional eyes with a refracting medium arranged in the manner of a large biconvex lens. These eyes seem to be useful for seeing near objects, as the larger are for distant ones. To say that either separately or the two together are better instruments than those that have a lens, is to assert what I suppose is not the case: and at all events it cannot be proved [t]. But the fact is, that in the complexity of nature, such discussions become trifling to the serious student, who recognizes in every direction amid many things that are difficult to explain, and some things that cannot be explained, an adaptation of means to ends

[t] For most beautiful dissections of the eyes of the Bee, and of Dytiscus, see Tafeln zur Vergleichenden Anatomie, von Dr. Franz Leydig, Pl. 8 und 9.

to a degree and in a kind which is overwhelming from its beauty and diversity; and who, at all events, takes pleasure in seeing variations, resemblances, correlations and adaptations, and in learning what he can of cause of origin, of mode of development, and of decay; seeking for a knowledge of what is, and not cavilling, or dreaming what might have been.

To explain this, one quotation shall be made from John Hunter, as illustrating the many circumstances which have to be taken into account in considering the fitness of any eye.

"An elephant has a smaller eye," he says, "than a horse; a squirrel and a rat have much larger eyes than a mole; although the progressive motion of a mole may be nearly as great as either; but it has no occasion for immediate extent of sight; it wants to see objects near, but must have a succession of them, because his food has but little motion, therefore it seldom comes to him; and for these his progressive motion is adapted.

"An eagle has nearly as large an eye as an elephant, perhaps the largest eye of any bird in proportion to size. An eagle does

not want a succession of sight, for his food is not stationary; he therefore wants at once to take in a large sphere of vision, that he may have a better chance to discover his prey; for this is such as has, in general, a good deal of progressive motion; therefore if he were short-sighted, he might as well be stationary, and the food would in its course come within his sphere of vision; but by a large eye, he has two advantages, viz. that of its coming in his way, and his seeing it at a considerable distance.

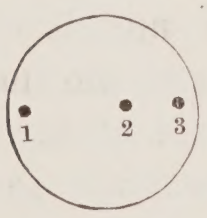
"The eyes of animals which see in the dark, and are also to see objects at some distance, are large, as much on account of the darkness as the distance of the object.

"The eye of an animal which can see an object at a mile's distance in the middle of the day, ought to be much larger to see the same object at the twentieth part of that distance at night; but as a substitute for the want of size, the motion of the iris and the white pigment or background assists[u]."

The whole argument shews that some vision is attainable without a lens, as many

[u] Hunterian Catalogue, by Owen; vol. iii. part i. p. 137.

seeing species have it not. The question of its exact use in man (as type of the highest sort) has been settled in an unanswerable manner. The lens, by alteration in form, adjusts the eye to distinct vision at varying distances. The fact suspected by Dr. Young has been proved by Cramer and Helmholtz. The proof depends on an observation of a very delicate nature, viz. on the position of images reflected from the cornea, and from the anterior and posterior surfaces of the lens. The images, except that on the cornea, are seen with difficulty, but by aid of Helmholtz's Ophthalmometer or Donders' Phacoeidoscope, or other instruments, with precision[v]. The three images may be rudely



represented thus: 1 is the image on the cornea, 2 that on the anterior surface of the lens, 3 that on its posterior surface. On accommodating the eye to near objects, 2 approximates to 1; and 3 is nearly stationary. Therefore the front of the lens has approached the cornea: the back of the lens has remained at the same distance as before,

[v] See Appendix, Note C.

therefore the antero-posterior axis of the lens has lengthened, and the lens has become more convex.

That some adjustment is physically necessary in the human eye has been admitted ever since the eye has been philosophically studied. The only mode of adjustment certainly known in the animal series is by the lens. It follows that Comte's attack is at best relative, and not absolute. Adjustment for distances is necessary. It is executed by the lens, which obeys the intention of mind without effort on the part of those who use it. And here it is not unworthy of note, that the state of rest in the lens is adapted to distant objects.

Two questions remain: first, whether the admitted want would have been better supplied, as is suggested by M. Comte, by human contrivance. It is unnecessary to enter on this speculation till a better method is actually before us for examination; and meanwhile the following grave judgment recently expressed by Darwin, as the result of his most matured reflection, is of as great weight as any other opinion that could be

adduced, and all the more because his knowledge of fact in Natural History, quite apart from interpretation, must be allowed far to exceed that of M. Comte :—

"The more I study nature, the more I become impressed with ever-increasing force with the conclusion, that the contrivances and beautiful adaptations....[w] transcend in an incomparable degree the contrivances and adaptations which the most fertile imagination of the most imaginative man could suggest with unlimited time at his disposal[x]."

Still there remains the second point, viz. that this lens, supposed by Comte to be so useless, and proved by Helmholtz to be so tenderly adapted to our necessities corporeal and psychical, is at all events calculated by its diseases to destroy altogether the action of the whole eye.

It is obvious that this attack is deprived of its sting if the organ be necessary. The sting is that a structure, which, at best, is useless, is placed in the middle of a delicate

[w] Some words, expressing his theory of natural selection and perpetual variation, are omitted.

[x] Darwin's Fertilisation of Orchids, p. 351.

instrument; that when itself is injured, it destroys the operation of the necessary portion: and that it is often injured.

To this the answer is, that in certain types of the finer kinds of vision the lens is, so far as we can see, necessary; and this is proved by the fact that, though, when it is removed, its loss may be to some extent compensated, yet the power of internal adjustment for distance is absolutely destroyed. It only therefore remains to discuss the diseases of it. The diseases are due to one of two causes: either to the general laws of change which in our world belong to all organic things, or else to evils incident to this structure and peculiar to it. It would not be sufficient, however, to shew that peculiar evils exist. For this is an exceptional structure for an altogether exceptional purpose, namely, the transmission of light through an organic whole; and requiring mathematical precision in respect of form, specific gravity, and refractive power generally. It must be shewn that the peculiar evils exist *per incuriam*, as it were. And this is presumably

the allegation of M. Comte. For the force of the charge is, as was said above, that the arrangement might altogether have been better. In reply to this, we can only repeat that the better way must be stated before it can be considered. Meanwhile we can discuss only the actual and existing way.

The real attack is, then, that the lens becomes diseased. It must be briefly but emphatically asserted in answer, that more arrangements exist for the protection of the eye (the lens included, of course) than for any other structure in the body; that the structure of the lens is almost exceptionally complicated; that it is altogether beyond human skill to imitate its minute structure; and that, considered as a whole and as it is, it suggests in a marked degree the feeling so prevalent among thinking persons of all ages,—a feeling increased by every modern research,—of helpless wonder that it can either be made at all, or, when made, that it can be maintained.

But still the lens does become diseased. It is almost pitiful to have to say that this is only one of the absolutely inscrutable

circumstances attending our whole condition. Why there is Physical Evil — Why there is Moral Evil, are questions, if not unanswerable, at least not yet answered. All we can say is, for us evil in all its forms, physical or moral, is but that[y] "against which the whole preventive force of our nature" may be and ought to be unceasingly exerted. The case therefore of the eye differs not from other cases: the only question should be, Is there more disease and failure in this beautiful structure than elsewhere? Of kindred non-vascular structures, certainly not. Statistics on such a point are at present impossible, but ordinary experience will shew that there is a vast preponderance of persons who have, at the worst, useful working power of vision, over those who have not.

Then for those who have not this working power (as far as the lens is concerned) their disorders resolve themselves, speaking generally and excluding heterologous deposits or traumatic injury, into disorders of the two elements, speaking histologically, of which

[y] Boole, Laws of Thought, p. 418.

the lens is composed. But the arrangement of these elements must be known before we can properly understand the abnormity[z].

The arrangements of the lens are simple: it is enclosed, as all know, in a delicate capsule. This membrane or capsule—perfectly transparent, bounded by a layer of transparent cells—allows transmission of nutrient plasma to the lens within. The lens itself is composed of tubes, placed in close apposition, more firm in the centre than towards the surface, and about .0025‴ to .005‴ broad[a]. These tubes are arranged in regular lamellæ; and these are united in such a way as to constitute the well-known stellate figure, which is shewn by preparation in the lens removed from the body, in the infant, and in early cataract.

In many animals the tubes or fibres are minutely dentelated at the edges. Sir David Brewster calculated that in each lens of the

[z] It has been lately described in detail, both in respect of its normal and abnormal structure, by Warlomont and Testelin, the able French translators of Mackenzie on the Eye.

[a] These are Kölliker's measurements. See Manual of Human Microscopic Anatomy, p. 568, ed. 1860.

codfish there are five million fibres, and sixty-two thousand five hundred million lateral dentations[b].

These structures—(1) the fibrous structure, and (2) the capsule—are liable to disorder. The lens is occasionally inaccurately placed; and is in its original formation, or congenitally, sometimes diseased, that is to say, not correctly made *ab initio*.

The alterations are chemical or mechanical, or both. That is to say, the chemical constituents of the lens either in their original affinities or in the progress of their interchange in life, acquire combinations unfavourable to the normal properties of the lens. Fat, cholesterine, or earthy salts become deposited, and the changes produce opacity, fluidity, hardness, change of form, and partial or total loss of the correct performance of the astonishing mechanism.

But now, the qualities necessary for the lens—preservation of an exact mathematical figure, perfect transparency, power of growth and of nutrition after formation, and alteration of figure for accommodation—are,

[b] Phil. Trans., 1833, p. 329.

and have been for untold ages, secured by the contrivances just described in millions on millions of individuals at every moment of time. Loss of figure, loss of power of nutrition alone would impair, in the nature of the case, the perfection of the quality in such a structure. Alter transparency, index of refraction, elasticity, in ever so small a degree, and the instrument is *destroyed*, or, short of that, *impaired*. Let us ask calmly, Is it *possible* in the existing order of the universe, where certain chemical elements by perpetual change of combination, so-called organic combination, endure for a while, pass off to enter into new combinations, and in the case of animals subject to conditions ever varying, whether of heat, moisture, position, or facility of access to fresh elements,—Is it possible, I say, that these combinations can go on in these myriads on myriads of organisms without occasional disturbances, as we call it—but, in truth, in general obedience *to a higher law of order than the condition of the individual?* Is it not rather a matter of extreme astonishment that the disorders of the lens are so infrequent, especially in the case

of civilized man, whose life is so artificial, and so unfavourable to rude health?

This then is the fact, that upon the whole and in the vast majority of instances an instrument is made, and maintained for some scores of years, by which with the help of contrivances adapted to it, we men (let alone the endless diversity of purposes in animals) are able to determine with the utmost precision, on the one hand, facts of position and colour in bodies at distances, if not infinite, yet beyond the power of measurement with the earth's orbit as the base, and on the other, to appreciate with the most perfect distinctness dimensions of even much less than the twenty-five millionth's of a square inch in area.

And, further, this instrument which has these optical and mechanical capabilities stands in exact relation to the mental powers in man, which enable him to profit by its provision, to use its revelations, to speculate on its teachings, to learn its lessons, and to analyze its nature.

Some apology should here be made both for the brevity and for the length of these

remarks upon the lens. For the brevity, to those who are not intimately acquainted with it; for the length, to those who are. They have been confined, it will be noticed, purely to the lens in its most restricted sense; and with regard to it they are of the most scanty kind. But the lens is not really more remarkable than other structures of the eye, and not so complicated by much as the retina. Had another part been selected by M. Comte for his crucial instance, nearly the same lesson would have been learnt, though we are not able now to appreciate and prove with as great exactness the properties of all its parts alike. Sufficient must have been said to enlist the sympathy of philosophic minds with members of an Institution such as is this, who, while themselves engaged in the serious study of the material world *as it is*, are compelled to see passing current among teachers of men, such as M. Comte assumes to be, sharp criticisms on what they admire and love—criticisms made apparently in great ignorance of facts. If the present occasion may be the means of awaking any such teachers of men

to the stern necessity of seriously looking into the actual structure of the material world, into what is its Order, and what are the facts of its apparent and inscrutable Evil, before dogmatically pronouncing upon the lessons it inculcates, then this discussion, however incomplete, will not have been in vain.

The consideration of Comte's attack on Final Causes, and specially on the Eye, may now be dismissed. The attempt of the Reformer of Philosophy appears to me to fail absolutely and hopelessly; and to give no support to the doctrine in behalf of which it is made. Yet the most remarkable answer to it has been withheld,—remarkable as coming from M. Comte himself, after the completion of his work on Positive Philosophy.

"The order of nature," says M. Comte, "is doubtless very imperfect in every respect; but its production is far more compatible with the hypothesis of an intelligent Will, than with that of a blind mechanism[c]."

[c] This passage is referred to by Mr. Mill in the "Westminster Review" for April, 1865. Mr. Mill was so good

It is unnecessary to add another word. No student of Nature worthy the name looks on the problem of this world as other than vast and inexplicable. He pretends no more than to see as by an image, darkly, and to bend before the Cause of all, which is by us unattainable, by us only mediately comprehensible.

We therefore part from the instance adduced by M. Comte, and return to weigh in a direct manner the influence of the notion of Final Cause on the minds of those who, like Harvey and Boyle, neither abuse it on the one hand nor reject it on the other.

In the first place, it may be said that if a man believes on the whole that behind all which we see and know there has ever been a Supreme Intelligence, and if he accept this interpretation in preference to that of fatal

as to refer me to the work where it is to be found. The words I have quoted from the English version by Dr. Bridges. See "A General View of Positivism," p. 50. (London, Trübner and Co., 1865.)

necessity or blind chance, then all contrivance becomes harmonious and probable. The Being of God accepted, the study of all things becomes a work of love, as it is a study of fact. When men are seen to dread the effect of Physical Science, it is not unreasonable to mistrust either the extent of their Culture or the strength of their Faith. But as without doubt there is an ignorant and superstitious, as well as cultivated and rational belief, the question remains to be answered, Did Harvey ignorantly and blindly hold dogmas in this matter which modern Science repudiates? There is no sign of it.

Harvey did, no doubt, believe in a Supreme Intelligence and Will. Modern Science has no proof against the soundness of this belief. An objection such as Comte's is an instance of a dogmatic assertion as arrogant as any ever made by religionists. All science goes to prove the existence of Order; and in Order[d] there is nothing that we *know* to exclude Design. Science is only the collection of what is proved in a certain

[d] See Appendix, Note D.

way, and arranged in a certain order. All questions not so arranged are, as far as Science is concerned, open. Science is only true in respect to the data discovered at a given epoch. Other data arise, and Science alters.

There are in Science three phases markedly distinct:

1. Mathematical and Arithmetical Truths, which are called *necessary*, i.e. which could not, so far as we know, be or have been otherwise: (as two straight lines cannot enclose a space).

2. Physical Truth, or uniform Laws of Nature, which, so far as we know, never vary, but which, so far as we know, might have been otherwise: (as organic types and their modifications).

3. Hypothetical Laws, which seem indeed to bind phænomena together, but which are not yet proved to be the true account of the matter, or may not be true: (as doctrines of Special Creations or of Natural Selection).

Not one of the bundles of real or supposed Truths contained in these divisions militates against the idea of a Supreme Intelligence. But Science as it advances has a tendency

to relegate the third into the second, and to confound the second with the first. Without attempting here to examine the metaphysical character of the first phase, it is plain that there is no colour for the assumption that the second is of that absolute and unchangeable character which would justify a philosopher in rejecting the notion of a Wise Creator and Governor of the Universe. Certainly this was not the tendency of Harvey's mind. His education and his epoch made him, as a believer, reverential: he was by nature modest, and being a sound observer he was neither superstitious nor illogical. The enquiry into what he did and believed will bring us to the correct understanding of what seems to be reasonable and what unreasonable in the belief in Final Cause.

Harvey was not guided in his discovery of the Circulation of the Blood by any metaphysical speculation or religious dogma whatsoever. He was learned in the learning of his age, and preeminently in that which was required from a Physician of that age, a knowledge of Hippocrates, Aristotle, Galen, and their followers. As he was well

acquainted with their writings, so their views doubtless gave colour to his mind. But far above all he was taught by Nature. A contemporary of Lord Bacon, he was not his disciple, though he was his Physician. Indeed Bacon's rash assertions in Natural Philosophy were offensive to him. He had the intellectual constitution of the great Reformer of Philosophy, with, as events shewed, a more practical power of applying it to the study of Nature. Without detailing all the steps by which he pursued his enquiry, it is thus he argues :—

"Thus far I have spoken of the passage of the blood from the veins into the arteries, and of the manner in which it is transmitted by the action of the heart; points to which some, moved either by the authority of Galen or Columbus, or the reasonings of others, will give in their adhesion. But what remains to be said upon the quantity and source of the blood which thus passes, is of so novel and unheard-of character, that I not only fear injury to myself from the envy of a few, but I tremble lest I have mankind at large for my enemies, so much doth wont and custom, that become as an-

other nature, and doctrine once sown and that hath struck deep root, and respect for antiquity, influence all men. Still the die is cast, and my trust is in my love of truth, and the candour that inheres in cultivated minds. And sooth to say, when I surveyed my mass of evidence, whether derived from vivisections, and my various reflections on them, or from the ventricles of the heart and the vessels that enter into and issue from them, the symmetry and size of these conduits—for nature, doing nothing in vain, would never have given them so large a relative size without a purpose—or from the arrangement and intimate structure of the valves in particular, and of the other parts of the heart in general, with many things besides, I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained, and the arteries on the other getting ruptured through the excessive charge of blood, unless the blood should

somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might not be A MOTION, AS IT WERE, IN A CIRCLE. Now this I afterwards found to be true; and I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large and its several parts in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery, and that it then passed through the veins and along the vena cava, and so round to the left ventricle in the manner already indicated[e]."

"But, lest any one should say that we give them words only, and make mere specious assertions without any foundation, and desire to innovate without sufficient cause, three points present themselves for confirmation, which being stated, I conceive that the truth I contend for will follow necessarily, and appear as a thing obvious to all. First—the blood is incessantly transmitted by the action of the heart from the vena cava to the arteries, in such quantity that

[e] Harvey's Works, translated by Willis, pp. 45, 46. Lond. 1847.

it cannot be supplied from the ingesta, and in such wise that the whole mass must very quickly pass through the organ; second—the blood, under the influence of the arterial pulse, enters and is impelled in a continuous, equable, and incessant stream through every part and member of the body, in much larger quantity than were sufficient for nutrition, or than the whole mass of fluids could supply; third—the veins in like manner return this blood incessantly to the heart from all parts and members of the body. These points proved, I conceive it will be manifest that the blood circulates, revolves, propelled and then returning, from the heart to the extremities, from the extremities to the heart, and thus that it performs a kind of circular motion[f]."

"To those who repudiate the circulation because they neither see the efficient nor final cause of it, and who exclaim *Cui bono?* I have yet to reply, having hitherto taken no note of the ground of objection which they take up. And, first, I own I am of opinion that our first duty is to enquire whether the thing be or not, before asking wherefore it is; for from the facts and

[f] Harvey's Works, translated by Willis, p. 48.

circumstances which meet us in the circulation admitted, established, the ends and objects of its institution are especially to be sought [g]."

"Whoever, therefore, sets himself in opposition to the circulation, because, if it be acknowledged, he cannot account for a variety of medical problems, nor in the treatment of diseases and the administration of medicines give satisfactory reasons for the phænomena that appear; or who will not see that the precepts he has received from his teachers are false; or who thinks it unseemly to give up accredited opinions; or who regards it as in some sort criminal to call in question doctrines that have descended through a long succession of ages, and carry the authority of the ancients;—to all of these I reply: that the facts cognizable by the senses wait upon no opinions, and that the works of Nature bow to no antiquity; for indeed there is nothing either more ancient or of higher authority than nature [h]."

And again:—

"That all this is so, sense assures us; and

[g] Harvey's Works, translated by Willis, p. 122.

[h] Ibid. p. 123.

necessary inference from the perceptions of sense takes away all occasion for doubt. Lastly, this is what I have striven, by my observations and experiments, to illustrate and make known; I have not endeavoured from causes and probable principles to demonstrate my propositions, but, as of higher authority, to establish them by appeals to sense and experiment, after the manner of anatomists [i]."

Harvey's own words, therefore, demonstrate how entirely he ranked observation above reasoning, and yet how he asserted the supreme force of correct reasoning upon fact, whether ascertained by simple observation of Nature or by experiment. How widely he, the first great English Comparative Anatomist, did observe and experiment, the list of animals of which he speaks (not, however, always correctly) will testify.

Here the matter might rest, were it not that Harvey is sometimes censured for his allusion to Aristotelic Causes in his discussions on the generation of animals. Critics who misunderstand the bearing of the

[i] Harvey's Works, translated by Willis, p. 134.

famous passage of Lord Bacon, "Causarum finalium inquisitio sterilis est; et tanquam Virgo Deo consecrata, nihil parit," may well be supposed to misunderstand Harvey's modest though too metaphysical disquisition on the Final Cause of an egg.

Aristotle distinguished four kinds of Cause, viz. Formal, Material, Efficient, Final[k]. The notions attached to these terms ruled all thought. Of these, the only one to which in modern science the name of Cause is given, is the Efficient. To call Matter a Cause of existence is use of words which no one would now adopt. But the most favourite of Aristotle's Causes, was the Form or Real Nature of the thing, which he proceeds to identify with both the Final and the Efficient Cause; the Real Nature or Essence of a thing being the End which is to be wrought out, and also the agent which works it out. And the same metaphysical refinement had overpowering attractions for

[k] For a brief analysis of these see Lewes' Aristotle, pp. 129, and sqq.; a book of great interest for any one who desires to see the present general relations and combinations of questions in which ancient and modern thought in physical science, metaphysics, and theology are concerned.

the mediæval minds. To them, nursed on the milk of Aristotle, the Form or Real Essence of things, and the Purpose for which any change takes place or any being exists, were the most interesting. But it is clear, for the reason already quoted from Descartes, that the purpose cannot be certainly known. Therefore, as Science is a methodized collection of what is certainly known, Final Causes (as they are still unfortunately called) or the investigation of the Divine purposes, however fascinating, however ennobling, must be simply speculative, and not cumulative of fact. There may be always purposes; we may be sure that often there are purposes beyond what we can see, if there be any purposes at all. Whether there be any is the object of Theological and Metaphysical, but not of Physical enquiry. As a man, the Physicist may suspect their existence, delight in their contemplation, provisionally employ them for hypothesis, but he may not use them as scientific data. When Harvey told Boyle[1]

[1] "Robert Boyle was much interested in this question. The elaborate treatise which he wrote on Final Causes, is

"that when he took notice, that the valves in the veins of so many parts of the body were so placed, that they gave free passage to the blood towards the heart, but opposed the passage of the venal blood the contrary way; he was invited to imagine, that so provident a cause as nature had not so placed so many valves without design; and no design seemed more probable, than that, since the blood could not well, because of the interposing valves, be sent by the veins to the limbs, it should be sent through the arteries, and return through the veins, whose valves did not oppose its course that way[m];" he in fact only used that common sense without which no investigation is possible. A bar that cannot pass through a ring, *could* not have been intended, by a skilful workman, to go through it. A bar

even now worth perusal for his good sense and fairness. See vol. v. of his Works in 4to. 1772. Dugald Stewart, in an equal dispassionate Essay, quotes him with much respect. Even now, these authors could not much alter conclusions, in which there is strong faith with no fanaticism." Boyle's conclusions are printed in the Appendix, Note E.

[m] Boyle's Works, ed. 1772, vol. v. p. 427.

that could enter *might* have been so intended. But after all such observations prove no more than that a fact or phænomenon is so, not that it was intended to be so. The evidence of intention is metaphysical, and depends on probabilities. It is not positive. It is inferential, from many considerations. Harvey does not, in speaking of the heart, enter into speculations. He adduces proof. But it must be acknowledged, that when Harvey speculates on the Final Cause of a chick, he confessedly and designedly deserts physical enquiry for metaphysical speculation. But even here, where we see his mind struggling in the meshes of the Aristotelic Causes, and labouring to identify the Form or Idea of the chick with its End or Purpose, there break through the cloud gleams of good sense and wisdom, such as might be expected from so practical an anatomist and experimenter. But he was not a man who would readily lay stress on data which were not proper as such; and his discussion on the Final Cause of the chick is wholly apologetic, so far as anatomical enquiry is concerned.

He has been adducing arguments to shew how ideas formed in the brain produce material results:—

"We, from the conception of the 'form' or 'idea' in the brain, fashion in our works a form resembling it;" i. e. the formal or generative Idea becomes the End which we aim at producing. . . . "The painter, by means of conception, pictures to himself a face, and by imitating this internal conception of the brain, carries it out into act; so also the builder constructs his house according to previous conception. The same thing takes place in every other action and artificial production."

"In truth, there is no proposition more magnificent to investigate or more useful to ascertain than this: How are all things formed by an 'univocal' agent? How does the like ever generate the like? And this not only in productions of art (for so house builds house, face designs face, and image forms image), but also in things relating to the mind, for mind begets mind, opinion is the source of opinion. Democritus with his atoms, and Eudoxus with his chief good, which he placed in pleasure, impregnated

Epicurus; the four elements of Empedocles, Aristotle; the doctrines of the ancient Thebans, Pythagoras and Plato; Geometry, Euclid. By this same law the son is born like his parents, and virtues which ennoble and vices which degrade a race are sometimes passed on to descendants through a long series of years. Some diseases propagate their kind, as lepra, gout, syphilis, and others. But why do I speak of diseases, when the moles, warts, and cicatrices of the progenitor are sometimes repeated in the descendant after many generations[n]? 'Every fourth birth,' says Pliny[o], 'the mark of the origin of the Dacian family is repeated on the arm.' Why may not the thoughts, opinions, and manners now prevalent, many years hence return again, after an intermediate period of neglect? For the divine mind of the Eternal Creator, which is impressed on all things, creates the image of itself in human conceptions.

" To illustrate the matter, let A stand for the fecundated egg (the 'matter' that is of the future chick), which is alterable or

[n] Arist. Hist. Animal. lib. vii. cap. 6; et De Gen. Anim. lib. i. cap. 17.

[o] Lib. vii. cap. 11.

convertible into the chick, and is in fact the chicken *in posse*. Let B be that which fecundates the egg, and thus distinguishes it from an unfruitful egg, *i.e.* the 'efficient cause' of the chick, or that which puts the egg in motion, and converts it into a chick. And let C be the chick, or 'final cause,' for the sake of which both the egg and that which fecundates the egg exist, the actual chick, namely, or 'reason' why the chick is.

"Now we take for granted, as demonstrated by Aristotle[p], that every prime mover is 'combined with' that which is moved by it. And these things are more particularly said by him to be 'together' which are generated or produced at the same moment of time: thus that which moves and that which is moved are actually together, and where one is there the other is also; for it is evident that when the effect is present the cause must be so too.

"Whenever, then, A (*i.e.* the fecundated egg) is actually in being, B (*i.e.* the internal moving and 'efficient' or fecundating cause) is also actually in being. But when B is actually in being, C also (*i.e.* the immaterial

[p] Physiologia, lib. vii. cap. 3.

'form' of the chick) must, at least in some sort, be existing too. For B is the internal efficient cause of the chick, that, namely, which alters A (the egg) into C (the 'reason' why the chick is). Since, then, everything which moves coexists with that which is moved by it, and every cause with its effect, it follows that C coexists with B; for the 'final cause,' both in nature and art, is primary to all other causes, since it moves, and is not itself moved; but the 'efficient' moves, because it is impelled by the 'final cause.' There inheres, in some way or other, in every 'efficient cause' a *ratio finis* (a final cause), and by this the efficient cooperating with Providence is moved [q]."

The whole discussion is interesting and well worth the attention of philosophic thinkers, as revealing the mental working of an eminent man in what in Art is called a Transition period—when two good styles are mingled, the advancing and the retreating tide exhibiting temporary forms. It is strange to find a man so practical as Harvey, so careful in observation, so exact in experiment, yet involved in these speculative doc-

[q] Harvey's Works, translated by Willis, pp. 582, 583.

trines of the Aristotelic school. It is strange to reflect that Bacon should have indignantly thrown aside these doctrines, but yet should have indulged in particular speculations in Physics, as unfounded as any that can come from the ancient school; and that Harvey, who in his investigation of the Circulation of the Blood gave a model of sound scientific procedure, should yet hold by the speculative doctrine of Causation, which Bacon had rejected. It is an instructive thing for us, who are living in an epoch as transitional and far more critical than that of Harvey. Calm judicial qualities are rare. The mass of scientific details which a man must master, the impatience of old notions, the dread of theological interference with progress on the one hand, and the just fear that man is to be in future allowed to hope for nothing that he cannot scientifically prove, make any general survey of metaphysical, religious, and scientific combinations, mistrusted or suspected by all parties. Yet this is to be deplored. Though one philosopher on behalf of Science may seek to eject from rational belief all that cannot be

proved, and though the logic of another may urge us to renounce on behalf of Theology such trust in the Infinite as is mainly supported by analogy with the Finite, yet assuredly this state is essentially transitional. If the disciples of Aristotle followed one part of their great Master's teaching to the neglect of the other, and were consequently chastised in epigram by Bacon's satire, we need not be guilty of similar excess, and seizing on Bacon's stricture on the ABUSE of Final Causes forget his exposition of their USE.

"The second part of Metaphysics," he says, "is the enquiry of Final Causes; which we note not as omitted, but as misplaced: for the enquiry of them usually is made amongst the Physiques, and not in the Metaphysiques.....And yet if this were a fault in order only, I should not much stand upon it, for order is a matter of illustration, and pertains not to the substance of Sciences; but this inversion of order hath caused a notable deficience, and brought a great decay upon Philosophy. For the handling of Final Causes in the Physiques, hath intercepted and banished the enquiry of Physical

Causes; and hath given men occasion to rest satisfied in such specious and umbratilous causes; and not thoroughly to urge and press the enquiry of Real and truly Physical Causes. For this I find done not only by Plato, who ever ancreth upon that shore; but also by Aristotle, Galen, and others, who usually likewise fall upon these flats. For to say, That the eye-lids furnisht with hairs are for a quick-set and fence to fortify the sight: or that the firmness of skins, and hides of living Creatures, is to repel the extremities of heat and cold: or that Bones are ordained by Nature for Columns and Beams whereupon the frame of the Body is to be built: or that trees shoot forth leaves to shadow and protect the fruit from the sun and the wind: or that the Clouds are engendered above, to water the earth below: or that the earth is close-compact and solid, that it may be a Station and Mansion for living Creatures, is properly enquired in Metaphysique; but in Physique they are impertinent [r]."

And further on he writes:—

"Aristotle is more to blame than Plato,

[r] Advancement of Learning, lib. iii. cap. 4.

seeing he hath omitted the fountaine of all finall causes, God; and in the place of God substituted Nature; and hath embraced Final Causes rather as a lover of Logique, than an adorer of Divinity. Nor do we therefore speak thus much, because those Final Causes are not true and very worthy the enquiry in Metaphysique Speculations; but because while they sally out, and break in upon the Possessions of Physical Causes, they do unhappily depopulate and waste that Province. For otherwise if they keep themselves within their precincts and borders, they are extremely deceived who ever think that there is an enmity or repugnancy between them and Physical Causes. For the Cause rendered, That the hairs about the eye-lids are for the safeguard of the sight, doth not indeed impugn that other Cause; that pilositie is incident to Orifices of Moisture, (Muscosi Fontes, &c.) . . . . Nor the Cause rendered, that the firmness of Hides in Beasts is for armour against the injuries of extreme weather, doth impugn that other Cause; That that firmness is caused by the contraction of Pores, in the outward parts of the body, through cold and depredation of ayre; and

so of the rest: both causes excellently conspiring, save that, the one declares an intention, the other a consequence only. Neither does this call in question, or derogate from Divine Providence; but rather wonderfully confirms and exalts it[8]."

Here we pause, and sum up the whole as regards the character of Harvey. HARVEY, believing in God, believed that there is purpose as well as harmony in the material world. He acted in this faith, and, using his reason aright, he made a mighty discovery which has influenced every biological student to this day, and will influence them to the end of time. COMTE, believing that theological tendencies are mischievous, and that the idea that the course of "NATURE is the ART of GOD" is mistaken and absurd, attacked one of the chiefest of these artistic works with sarcasm, which, from its assumption and its ignorance, recoils on himself, notwithstanding his knowledge and genius. BACON, who is sometimes put forward as a keen opponent of the belief that we can see evidence of Design in Nature, objects only to the misuse

[8] Advancement of Learning, book iii. cap. 4.

of the Method,—misuse which must occur whenever persons fancy that they are studying the means when they are but asking the purpose. As strongly as any man, Bacon holds up the contemplation of Ends in Nature as work worthy of a philosopher, in its proper time and for its proper purpose.

Of Harvey, then, we may here be satisfied that even in a purely scientific point of view his methods were right. By observation, by experiment, by reason; by faith in a Supreme Will, whom the reason cannot comprehend, but whom the heart can approach, in modesty and in patience he pursued his task. In the closet and by the bed-side, in the dissecting-room or in the outer world, may we think from time to time of that keen and gentle spirit whom the marble by our side has made so familiar; a spirit that may safely be looked up to by all students of Nature, who, whether they are ascending the hill of life, or, having reached its summit, are looking down the slope on the other side, are willing to learn not those lessons only which rigid proof impresses with the force of necessity; but can listen to those

subtler sounds which stir to hope and belief the willing heart, rising faintly yet certainly from time to time, as a wayworn traveller hears ever and anon the deep though distant roar of ocean on an unseen shore!

In conclusion, it should be borne in mind that the object of this Essay has been not so much to consider the bearing of the whole of Harvey's methods of research, as to examine, as far as time would permit, whether one conviction of his mind, the correctness of which is now much called in question, is to be repudiated as unworthy a scientific man. It must be remembered that we claim for the scientific student the privilege of using all methods of intellectual progress which the laws of thought allow. But the same method is not applicable to all subject-matter. If into pure science anything be admitted which is not based either on correct observation, or legitimate logical deductions from it, the whole constructed fabric totters as Science. Hypotheses, when employed, are to be narrowly watched, lest they slip into the category of accepted Fact.

The right appreciation of the character of

Science ought to cement into close union the Theologian and the Scientific man, instead of, as now, too often dividing them. What do I know? what do I hope? and what reasonably believe? are widely different questions. But they are correlative one of the other, and together make the sum of that portion of human experience by which man strives to work his way in the labyrinth of his present state.

Though we are not in this place unconscious of these things, it is not our special work to harmonize them. The comprehensiveness of Harvey's character, and the crucial instance of the Positivist leader, have drawn us into the discussion of them. Our ordinary duty, however, is clear enough. It is the duty well discharged by such as Kirkes and Baly, among those that are recently gone; by many yet living; and will be, we hope, by many more yet to come, under the increasing advantages of education, and the great opportunities of this Metropolis. It is the duty of precise and accurate observation of the structure of man in health and in disease,—tested and examined with all the

means supplied by an age of unprecedented research and industry, and a time of unexampled material reward from the "Vera indagatio Naturæ." The study of Physics, Chemistry, and the Microscope, draw on the Healing Art each day step by step more near to an Accurate Science, where facts are fully proved, where argumentation is rightly used, where loose opinions are discarded, and where every error, so far as may be, is guarded against.

It is not too much to express the hope that we, on the one hand, are doing all that in us lies to possess ourselves of these accurate powers; and on the other, that the public will become so instructed in the principles of Science as to be able to appreciate the immense progress that has already been made in the cultivation of sound and scientific medicine, and to estimate justly the great acquirements now expected of our younger well-trained men!

APPENDIX.

Note A, to p. 10.

"If we consider microscopical observations, for instance, and perceive very numerous species of animals in a single drop of water, robbers accoutred with instruments of destruction, and which, whilst intent on persecuting others, are overwhelmed by still more powerful tyrants of this aqueous world; when we see the enmity and strife, the power, and the scene of rebellion in a single globule of matter, and look up in a clear night and behold the immense space filled with worlds which appear like particles of dust; no human language has words to express the feeling which such an intuition excites, and all subtile metaphysical dissections yield to it very much in point of grandeur and sublimity."—Kant's *Metaphysical Works*, translated by J. Richardson, pp. 134–136.

Note B, to p. 13.

"As to the manner of demonstrating the first, I shall, without entering into deep speculations, like some philosophers, seriously intreat every one, that with a composed mind, and divesting himself of his passions and prejudices, he would silently set down and seriously consider, *First*, in case he should see that

1. Not one, but a great many,
2. And various or different

3. Things entirely ignorant, or unknowing of all, and even of themselves too :

4. Each of them frequently after a particular manner

5. However always unchangeably, and observing the same rule ;

6. Do act and move not once, but upon many occasions and times.

7. And not one of all them able to impart such *motion* to itself ;

8. Nor unless they thus come together of themselves, can produce one single effect without their own knowledge :

9. In the production of which effect or thing, if some few circumstances only, or oftentimes but one single one were wanting, it could not either be produced at all, or at least not in its due perfection ;

10. Although that same effect should in itself be of great use and service, and sometimes of the utmost importance.

Could he imagine otherwise than that all these things are formed to that end, and brought together with that design, to work such an effect as we observe to be produced by them ?

And, *Secondly*,

Supposing this first to be true, since these things are in themselves ignorant and unknowing of all that passes ; whether everybody must not agree, that they are all produced, and made to concur by a wise and understanding agent, who had such an end and design in his view ? And whether any one can persuade himself that mere chance, and unknowing laws of nature or other causes ignorantly cooperating, could have place therein, and could have directed and governed these things in all their circumstances and motions for such a purpose ?

That this may be shewn after a more plain and not less certain manner, let us apply to some particular thing what has been just now advanced in general, and as it were in an abstracted manner; and let us suppose that in the middle of a sandy down, or in a desert and solitary place, where few people are used to pass, any one should find a watch, shewing the hours, minutes, and days of the months, and having examined the same, should perceive so many different wheels, nicely adapted by their teeth to each other, and that one of them could not move without moving the rest of the whole machine; and should farther observe that those wheels are made of *brass* in order to keep them from rust; that the spring is of *steel,* no other metal being so proper for that purpose; that over the hand there is placed a clear glass; in the space of which if there were any other but a transparent matter, he must be at the pains of opening it every time to look upon the hand: besides all which, he might discover in it a hole, and exactly opposite thereto a little square pin: he would likewise see hanging to this same watch a little key composed of two pieces, making a right angle together; at the end of each of which there was a square hole so ordered that one of them was exactly adapted to the little pin in the said hole, which being applied thereto a chain would be wound up, and a spring bent, by which means the machine would be continued in motion, which otherwise would be in an entire rest: he might also find that the other square cavity, at the end of the little key, was adapted to another pin or instrument, which being turned this way or that, makes the hand move faster or slower. At the other end of this little key there would be a flat handle, which being moveable therein, might give him the conveniency that in the winding it up he should

not be obliged to take hold of it at every turn of his fingers.

Lastly, he would perceive that if there were any defect either in the wheels, spring, or any other parts of the watch, or if they had been put together after any other manner, the whole watch would have been entirely useless.

Now the question is, in order to form a kind of demonstration from hence, *First*, Whether anybody can imagine that such a watch among other purposes to which it might perhaps be serviceable, was not likewise made for this end, that it should shew the hours, minutes, and day of the month. *Secondly*, Whether he should make the least scruple to admit it for a truth that such a machine was made and put together by an understanding artificer for this very purpose, who, when he made it himself, knew that, and to what end he had made it.

And *Thirdly*, Whether it be possible that he can persuade himself that this watch, with all belonging to it, the niceness of its make, figure of so many parts, and other contrivances for shewing the time, could have acquired its being and form by mere chance only, which operated indifferently one way or another, and without any certain rule or direction.

Or otherwise, whether he could expect to pass for a man of sense and understanding, if, having found this watch in a solitary place, he should pretend to believe that it was not made by a skilful workman, nor that its parts were put together with judgment; but that there was a certain ignorant and yet necessary law of nature prevailing in the world that had brought into a regular method all the parts of which this watch consisted, and had adapted each of them to the use of shewing the time of the day; and especially that such a law of nature was not only ignorant

and unsensible of all that it did, or brought to pass, but likewise, that no being, endued with any wisdom or understanding, had established and produced this law at the beginning, or in the least contributed to the making the several parts that composed a machine proper to shew the hours.

What has been said above concerning a *watch*, is not less applicable to all other artificial works ; it will be therefore unnecessary to allege any further examples of *mills*, *ships*, *sluices*, *houses*, *paintings*, &c., in all which the wisdom and understanding of the maker does equally appear.

Finally, We may apply all that has been said above to demonstrate that there is such a Wise, Mighty, and Merciful Being as God, in case we can make appear with as great (not to say a much greater) certainty and conviction, from the construction of the visible world, and all that passes therein, that there is a God and Great Creator, who in wisdom has made them all ; as we can shew from the structure of a watch, and the uses that result from the same, that it has been made and put together by a judicious and skilful workman ; and this we doubt not of doing in the following contemplations, with all necessary clearness."—pp. xliv–xlvii of Preface to Nieuwentyt's *Religious Philosopher*, translated by J. Chamberlayne. Lond., 1718, 3 vols. 8vo.

Note C, to p. 38.

Helmholtz's Ophthalmometer may be obtained from the obliging and able constructor, Herr Dr. Meyerstein, Göttingen ; Professor Donders' Phacoeidoscope either from Utrecht or from Messrs. Powell and Lealand, London. This last instrument, though not necessary for shewing the images, is of great help ; but it does not supply the

place or perform the work of the Ophthalmometer. A translation of Helmholtz's papers on the whole subject is a desideratum.

After the delivery of the Oration, Mr. BOWMAN, F.R.S., was so good as to exhibit the images, and their change on adjustment, to those who could enter the small darkened room, including H. R. H. the Prince of Wales, Mr. Gladstone, Mr. Cardwell, and the President of the College, and many others. And I desire here to record my grateful thanks to Mr. Bowman for this and many other kindnesses.

Professor BEALE, F.R.S., shewed in the same obliging manner many skilful preparations illustrating the structure of the lens.

NOTE D, to p. 51.

"IMPROVED views, increased and accumulating evidence of the harmony pervading the material world, are attained in proportion to the advance of sound inductive science. The more close adherence to the spirit of philosophic analogy leads to a more commanding sense of the uniformity of nature, and the true idea of causation. As the generalizations of physical science become more comprehensive, we acquire juster notions of the stupendous aggregate of physical causes, of the inconceivable vastness and complexity of that universal mechanism, some small portion of which we are enabled to understand; and whose recondite and perfect adjustment, however imperfectly perceived, is the true ground and evidence of our conceptions, partial and limited as they must be, of the Infinite source of all things.

It is not a mere desultory and fragmentary knowledge of detached facts and portions of science, to however great an extent it be carried, which can suffice to lead us to a

correct perception of those truths. It can only be by a thorough insight into the interior principles of the inductive philosophy, and an imbibing of its real spirit, that we can attain adequate perception and sense of the real unity of nature which forms the basis and substance of those more sublime inferences.

In the confined and literal notions, often ignorantly entertained, of the sciences of observation, our conclusions might be supposed restricted to the field of mere sensible experience; and in this sense we should fall short of any worthy apprehension of the supreme intelligence. But the truly inductive philosopher extends his contemplation to intellectual conceptions of a higher class, pointing to order and uniformity as constant and universal as the extent of nature itself in space and in time; and in the same proportion he recognizes harmony and arrangement invested with the attributes of universality and eternity, and thus derives his loftier ideas of the Divine perfections.

The real nature and bearing of the evidence of natural theology as founded on *universal order*, has in fact come to be better understood only in an age of advanced philosophic cultivation: it tends to become continually more perfect with increasing knowledge; and its full force is hardly yet commonly apprehended even among men of science."—Baden Powell, *Essays on the Spirit of the Inductive Philosophy, the Unity of Worlds, and the Philosophy of Creation*, Lond. 1855, pp. 159–161.

Note E, to p. 62.

"The result of what has been hitherto discoursed, upon the four questions proposed at the beginning of this small treatise, amounts in short to this:

That all consideration of final causes is not to be banished from natural philosophy; but that it is rather allowable, and in some cases commendable, to observe and argue from the manifest uses of things, that the author of nature pre-ordained those ends and uses.

That the sun, moon, and other celestial bodies, excellently declare the power and wisdom, and consequently the glory of God; and were some of them, among other purposes, made to be serviceable to man.

That from the supposed ends of inanimate bodies, whether celestial or sublunary, it is very unsafe to draw arguments to prove the particular nature of those bodies, or the true system of the universe.

That as to animals, and the more perfect sorts of vegetables, it is warrantable, not presumptuous, to say, that such and such parts were pre-ordained to such and such uses, relating to the welfare of the animal (or plant) itself, or the species it belongs to: but that such arguments may easily deceive, if those that frame them are not very cautious, and careful to avoid mistaking, among the various ends that nature may have in the contrivance of an animal's body, and the various ways which she may successfully take to compass the same ends. And,

That, however, a naturalist, who would deserve that name, must not let the search or knowledge of final causes make him neglect the industrious indagation of efficients." —*Robert Boyle's Works*, vol. v. p. 444, 1772.

"... But judging that his (Des Cartes') doctrine (at least as it is understood by several of his followers, as well as his adversaries) about the rejection of final causes from the consideration of naturalists, tends much to weaken (as is elsewhere noted) if not quite to deprive us of one of the best and most successful arguments to convince men that

there is a God, and that they ought to admire, praise, and thank Him ; I think it my duty to prefer an important truth before my respect to any man, how eminent soever, that opposes it, and to consider more the glory of the great Author of nature, than the reputation of any one of her interpreters.

And to strengthen what I have been saying, give me leave to mind you more expressly here of what I have elsewhere intimated, viz., that the excellent contrivance of the great system of the world, and especially the curious fabric of the bodies of animals, and the uses of their sensories, and other parts, have been made the great motives, that in all ages and nations induced philosophers to acknowledge a Deity, as the author of these admirable structures ; and that the noblest and most intelligent praises, that have been paid Him by the priests of nature, have been occasioned and indited by the transcending admiration, which the attentive contemplation of the fabric of the universe, and of the curious structures of living creatures, justly produced in them. And therefore it seems injurious to God, as well as unwarrantable in itself, to banish from natural philosophy the consideration of final causes ; from which chiefly, if not only, I cannot but think (though some learned men do otherwise) that God must reap the honour that is due to those glorious attributes, his wisdom, and his goodness."—Boyle, *Disquisition about the Final Causes of Natural Things*, Works, vol. v. p. 401, 1772.

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